

# Vertex Detection in High-Energy Physics

Detectors for high-energy physics comprise various subsystems to measure different parameters of the interaction products.

A typical detector at a colliding beam accelerator includes

1. Vertex detection  
to determine the position of the primary interaction and secondary decays
2. Precision tracking in a magnetic field  
momentum measurement
3. Calorimetry (Electromagnetic + Hadronic)  
energy measurement
4. Muon detection

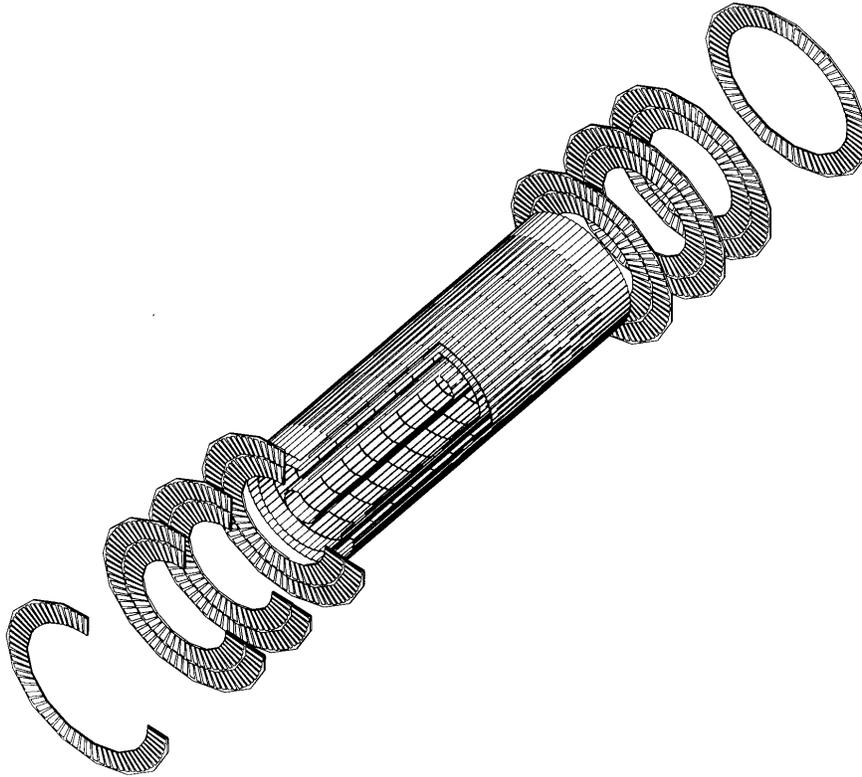
Vertex detectors have become critical components of modern detectors.

These systems rely on silicon sensors with 5 – 10  $\mu\text{m}$  position resolution at radii of  $\sim 10$  cm.

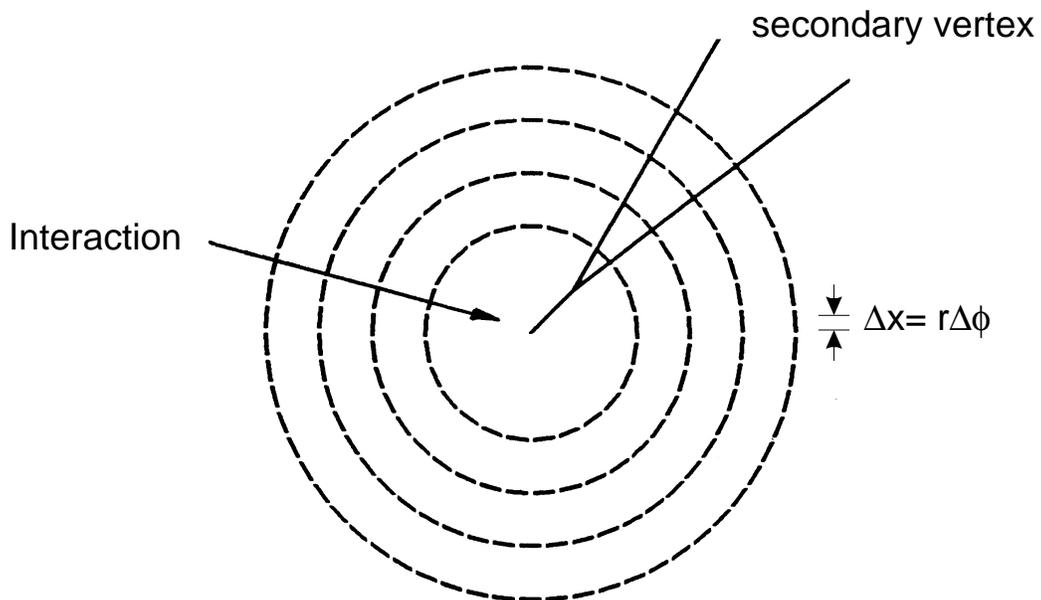
The high density of detector elements requires highly integrated readout electronics, monolithically integrated on silicon chips.

These readout ICs are highly specialized, so they are not available commercially. Determining the architecture and optimum technology, and then designing and system testing these ICs are among the main activities in the construction of large detector systems.

## Typical configuration of a modern vertex detector



Resolution is provided primarily in azimuth, i.e.  
radial electrodes in the disks,  
electrodes parallel to the beam axis in the barrel:



# Discovery of Top Quark (CDF data)

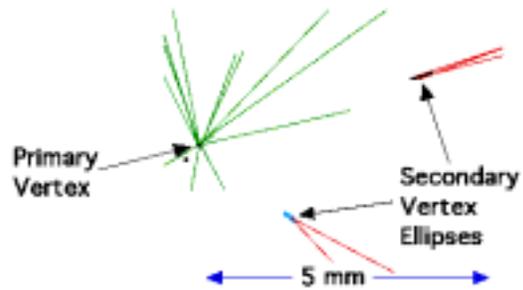
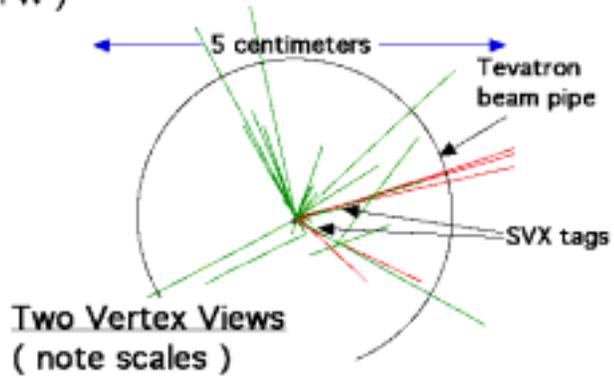
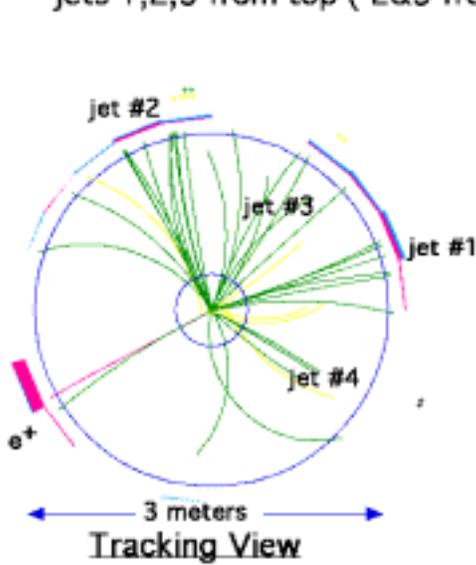
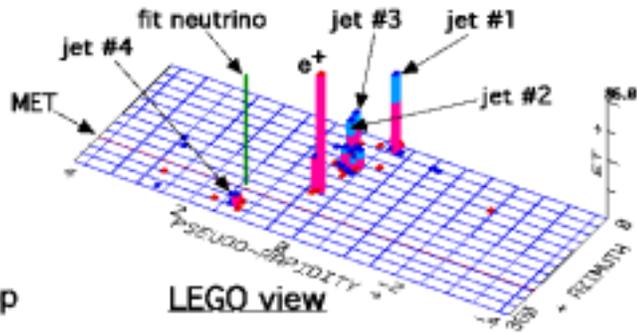
Unique identification of the top quark by detecting secondary vertices in a high-resolution silicon vertex detector:

## e + 4 jet event

40758\_44414  
24-September, 1992

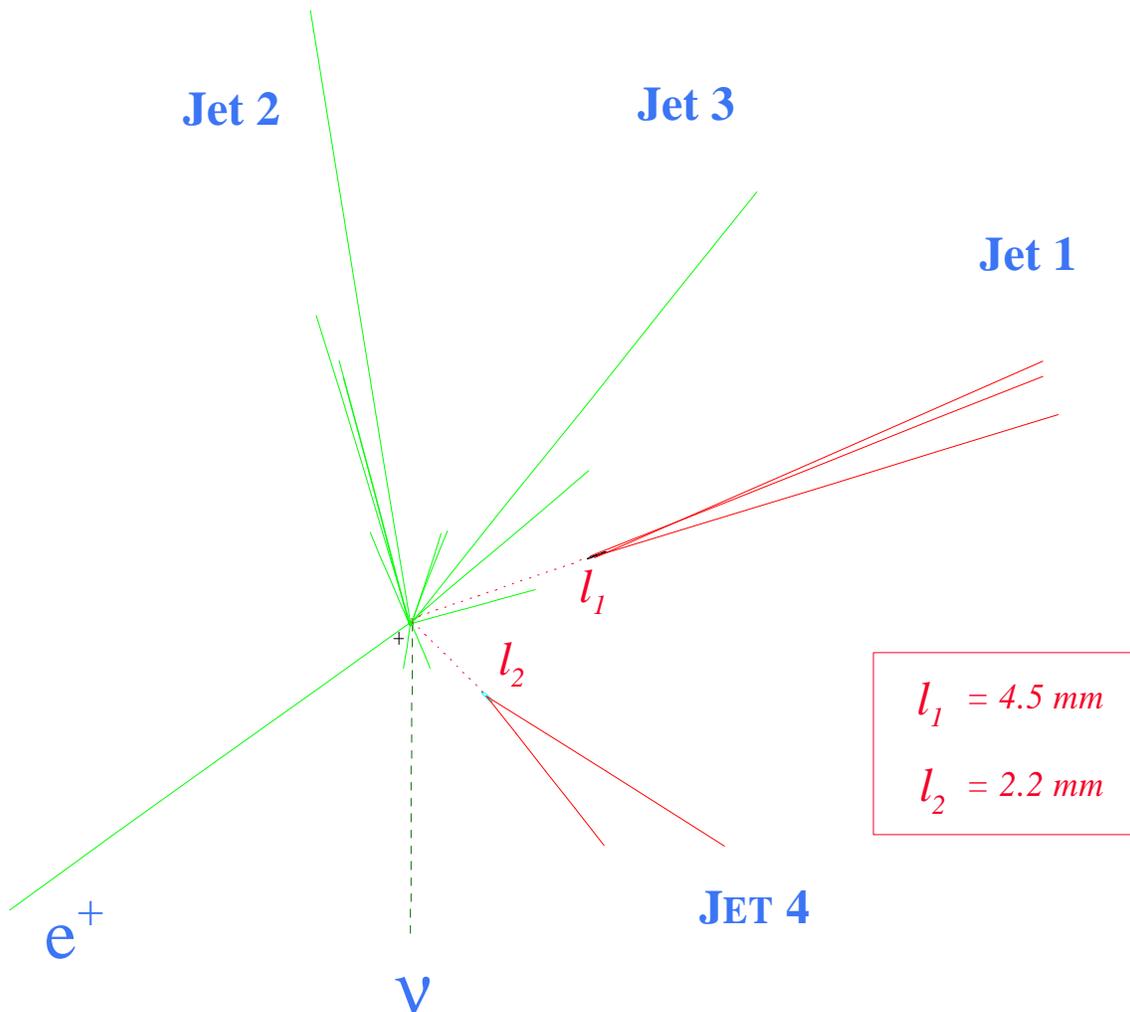
TWO jets tagged by SVX  
fit top mass is  $170 \pm 10$  GeV

$e^+$ , Missing  $E_T$ , jet #4 from top  
jets 1,2,3 from top ( 2&3 from W )



zoom in on secondary  
vertices (next page)

# $t\bar{t}$ Event SVX DISPLAY CDF



$$M_{\text{top}}^{\text{Fit}} = 170 \pm 10 \text{ GeV}/c^2$$

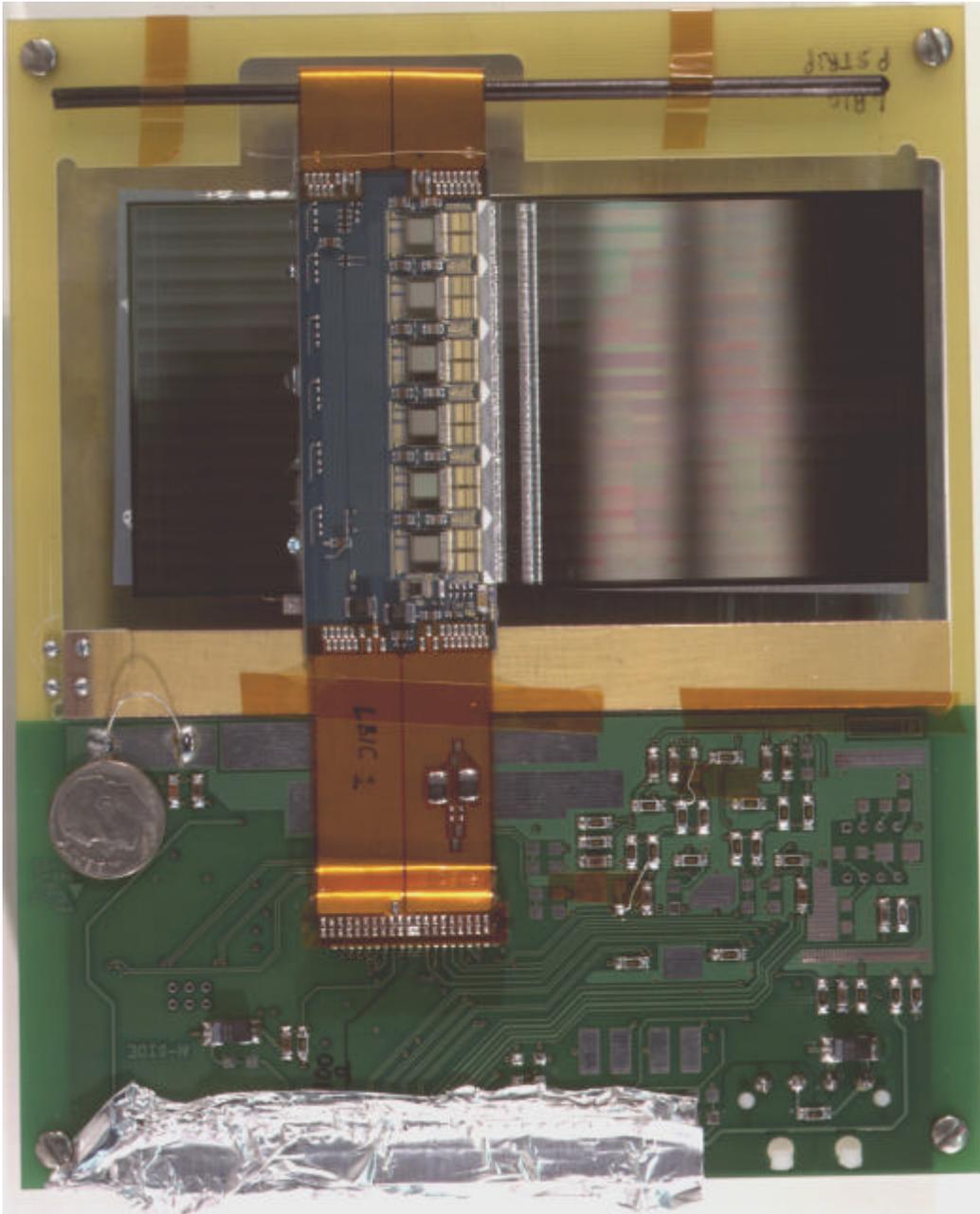
24 September, 1992  
RUN #40758, EVENT #44414

## A representative silicon detector module

readout ICs  
↓

wire-bonds  
↓

silicon detector  
↓



The module is mounted in a pc-board support frame to facilitate handling during test. The module itself is the rectangular object in the upper half of the picture.